



Grid Integration -Applications and Implementation Activities



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**FY 2005 DOE Wind Program Implementation Meeting
November 16 -18, 2004
Omni Interlocken Hotel
Broomfield, Colorado**



UWIG – A key technical partner



- Growing membership and recognition as *The* focal group for information
- Establishment of 4 “User Groups”
 - Operating Impact and Integration Studies
 - Distributed Wind Applications
 - Wind Plant Modeling and Interconnection
 - Market Operation and Transmission Policy Best Practices
- Foundational “Wind Integration & Interconnection Workshop” cosponsored with AWEA, CIGRE, NREL/DOE, Albuquerque, May
- Additional technical meetings 10-03 Seattle, 10-04 Albany



UWIG – Other work

- Participant in many operational impact studies and reviews (Xcel, MN DPS, NY ISO)
- Suggested as repository of turbine and wind farm models by AWEA
- Participation in FERC proceedings and workshops
- Planned Short Course on the Integration and Interconnection of Wind Power Plants into Electric Power Systems Feb 14-16, Palm Springs



NWCC – Transmission Analysis and Outreach



- Case Studies
- RTO Briefings
- RTO Principles
- Comments on FERC RTO & SMD NOPRs
- Transmission Issue Briefs
- Transmission Planning Workshops
 - Midwestern
 - Western
 - Southwestern Power Pool
- Transmission Planning Principles



Transmission Case Studies



- Purpose
 - Inform members on complex issues affecting wind power expansion
 - Provide information and insights useful to others dealing with same issues
- Completed 4 case studies on Transmission Policy and Pricing in Texas, Virtual Wheeling, Transmission Planning in the Upper Midwest, and Wind in the CAISO
- Starting 4 new case studies on transmission for wind in TX, WI, CO, and CA



NWCC Transmission Work Group Impact



- Provides communication and education in both directions for hundreds of people
- RTO principles influenced market evolution and FERC SMD
- Transmission planning principles can influence the transmission planning process
- Midwest workshop led to MISO MTEP Wind Scenario with 10,000 MW of wind
- NWCC provides the focus and forum to actively engage on an ongoing basis, compared with previous approach of contested case proceedings

Capture Benefits of New Turbine Designs

Wind generator
Electrical Models
for Interconnection
studies

Tools and Methods Development

Transmission &
Generation
Planning

Characterization
of Operational
Impacts

Application & Implementation

Grid Rules
Development

Mitigation
strategies

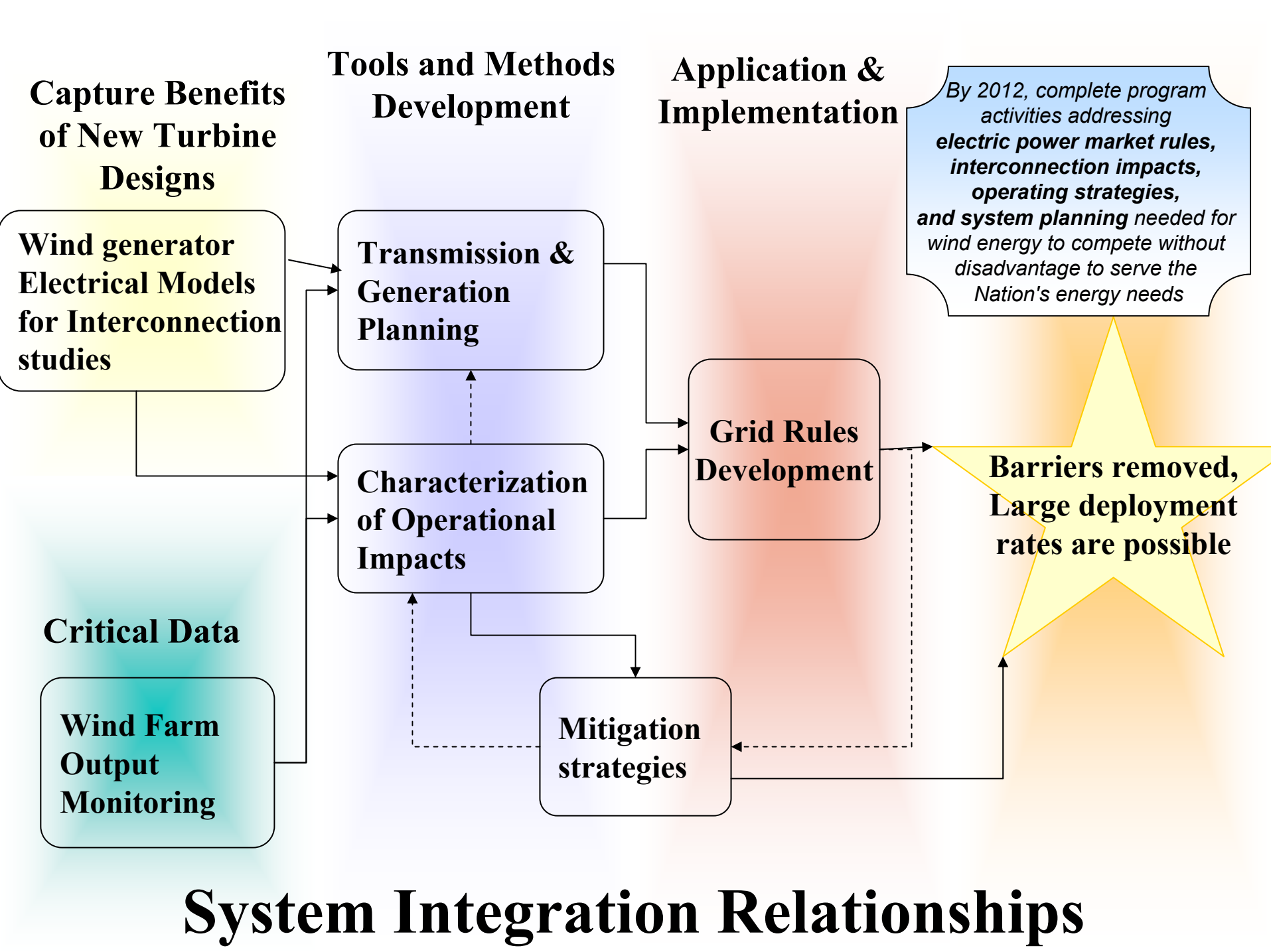
By 2012, complete program activities addressing electric power market rules, interconnection impacts, operating strategies, and system planning needed for wind energy to compete without disadvantage to serve the Nation's energy needs

**Barriers removed,
Large deployment
rates are possible**

Critical Data

Wind Farm
Output
Monitoring

System Integration Relationships





Operational Impacts Work Highlights



- Technical Review Committee for MN DPS study of 15% wind
- Methods input for NY ISO study by GE
- Comments and technical assistance for WAPA Loveland regulation tariff proposal
- Regulation and load following analysis for CA RPS integration studies
- Wind/hydro case studies with Arizona Power Authority and Missouri River underway



What we know

- ***Drivers include***
 - Size of control area
 - Geographic dispersion of wind
 - Conventional generation characteristics
 - Operational practices
- Key: ***system balance***, not individual balance
- Costs appear moderate, with day ahead scheduling and forecasting being the largest impact



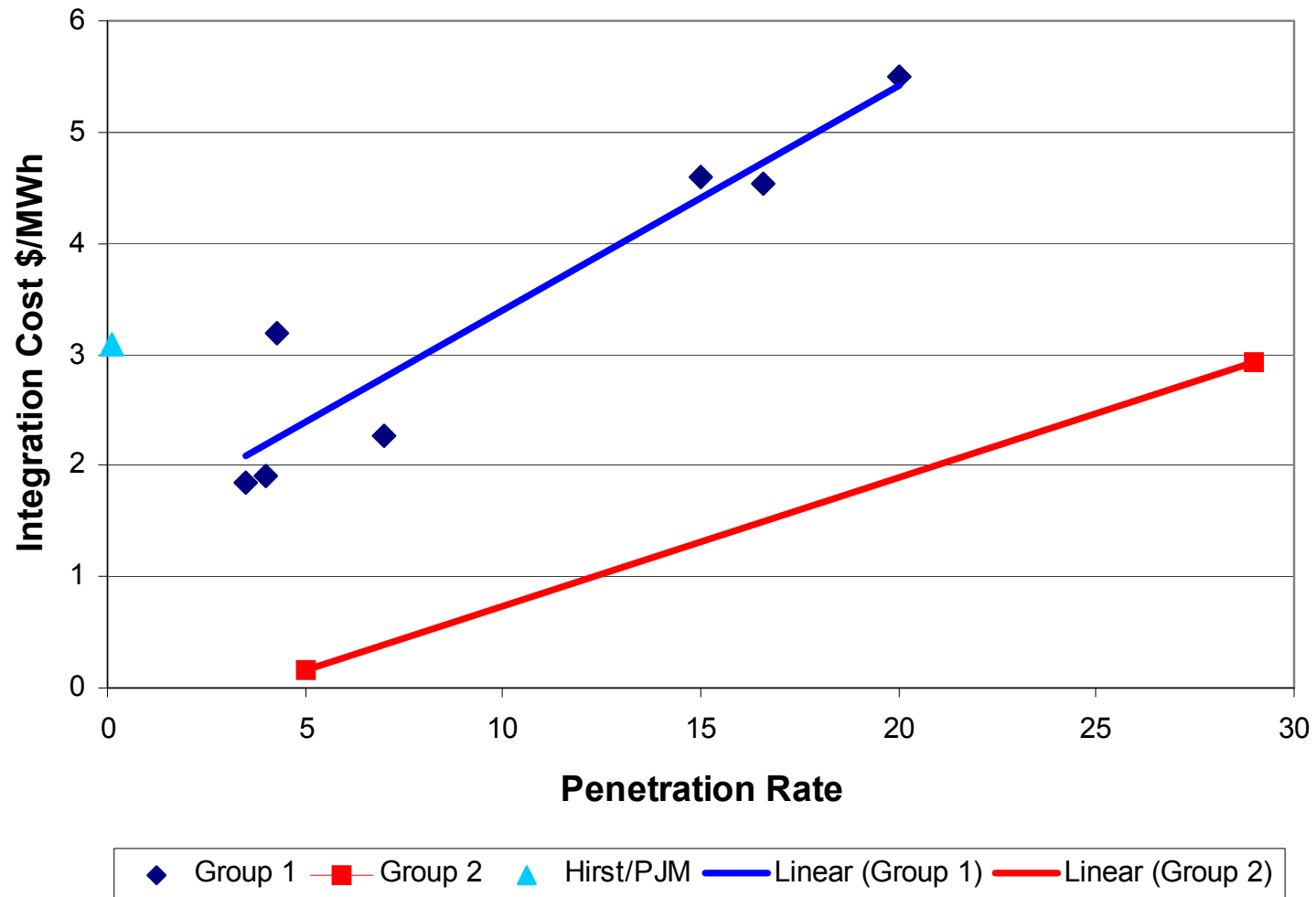
What Else Would We Like to Know



- Shape of the A/S cost curve (high penetration level)
- Sensitivity of results to
 - market structure and pricing
 - generation mix and fuel cost
 - transmission congestion
- More insights and a few “rules of thumb”
- Better understanding of the impact of wind forecasting
- *What new operational practices would help with wind integration?*
- Specific operator response to extreme events (operational simulator)



Wind Integration Cost Studies





Operational Impacts Planned work



- Methods Development and Technical Review Committee for higher penetration studies by Xcel
- Areva operational simulator analysis: Methods and case studies (SMUD, others?)
- Methods development using GE MARS (incorporates transmission as well)
- Continue interaction with WAPA Loveland
- Increased international technical exchange (Ireland, Thomas Ackerman, IEA)
- Complete Wind/hydro case studies

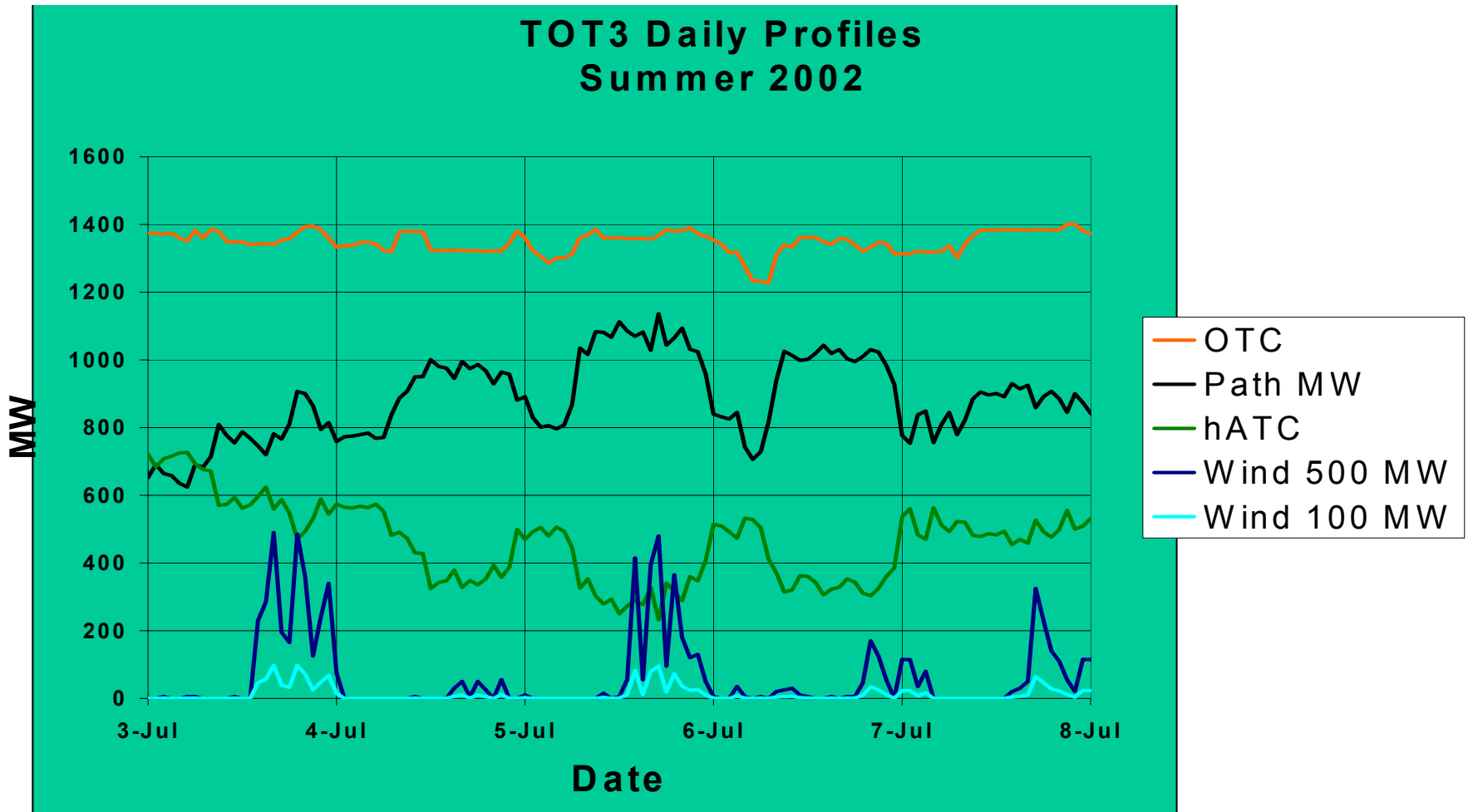


Transmission and Generation Planning Work Highlights



- ELCC analysis for CA RPS integration studies
- Technical interaction with Southwest Power Pool generation working group
- Rocky Mountain Area Transmission Study wind development scenario and long-term, non-firm transmission concept analysis
- Completed congressional report on “Comprehensive assessment of wind resources and transmission issues in the Dakotas”

Comparison of Available Transmission Line Capacity and Wind Power Profiles



This concept and case study is expected to be highlighted at Dec. 1 FERC conference on Assessing the State of Wind Energy In Wholesale Electricity Markets in Denver



Transmission and Generation Planning: New Work



- Further capacity credit methods work with GE MARS, Xcel
- Geographic diversity power profile modeling task initiation
- Methods and technical review role in WAPA Dakotas study
- Participate in transmission planning exercises in Northwest and Southwest (Western Governors initiative tie), update for Upper Midwest
- Continue developing alternative transmission product ideas with grid stakeholders (WAPA, PacifiCorp, BPA)



Milestones from Current MYTP



Systems Integration

2003	2004	2005	2006	2007	2008	2009	2010+
	2						
Technology Characterization and Data Collection							
	1 3 6						
Tools and Methods Development							
	4 5	7	8	9			
Application and Implementation							

Milestones

1. Facilitate development of transmission scenarios for two regions through NWCC planning forums
2. Complete one year of wind farm data collection for 3 RTOs or utilities
3. Complete dynamic models of wind farms and clusters for grid-level and distribution-level influences harmonics, machine dynamics, flicker, reactive power
4. Updated version of Hybrid2 software
5. Draft reports on hydro integration analyses for two river basins
6. Publish methods for treating wind in grid scheduling framework
7. Promote development of consensus utility transmission planning principles
8. Complete high penetration study, with validation, for one RTO
9. Complete mitigation study for RTO studied in 2006



Additional Prospective Milestones



- Tools and Methods Development
 - Facilitate and publish comprehensive summaries of wind's impacts on electric-system operation and ancillary-services costs(2006, 2008, 2010)
- Technology Characterization and Data Collection
 - Facilitate availability of efficient wind-plant electrical models for representative wind generation hardware(2006, 2008, 2010)
- Application and Implementation
 - Complete primer for utilities on expected operational impacts of wind power (2005)
 - Complete three case studies of wind forecasting value (2006)
 - Complete comparative evaluation of capacity accreditation methods (2007)
 - Complete evaluation and recommendations for high-wind penetration scenarios based on production of electricity and hydrogen (2009)
 - Complete recommendations for long-range power system planning that optimizes the realization of wind power's overall benefits from a comprehensive IRP perspective (2012)
 - Complete periodic reviews by SI Expert Group (2005, 2007, 2009, 2011)

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